WHAT IS CLAIMED IS:

1. A hydrogen combustion heater comprising:

a passage for allowing hydrogen gas and air to flow therethrough;

a first catalyst provided in said passage, said first catalyst being heated, when electricity is applied thereto, thereby starting a first combustion of a first mixture of said hydrogen gas and said air in said first catalyst; and

a heat exchanger provided downstream of said first catalyst in said passage, said heat exchanger being adapted to transfer heat generated by said first combustion to a heating medium of said heat exchanger.

2. A hydrogen combustion heater according to claim 1, wherein said first combustion is limited to a mild oxidation that is defined as being free from firing of said hydrogen gas.

3. A hydrogen combustion heater according to claim 2, wherein said first combustion is limited to said mild oxidation by controlling a flow rate ratio of said air to said hydrogen gas.

4. A hydrogen combustion heater according to claim 3, wherein said flow rate ratio is controlled to be greater than 8:1.

5. A hydrogen combustion heater according to claim 4, wherein said flow rate ratio is controlled to be about 15.3:1.

6. A hydrogen combustion heater according to claim 1, further comprising a second catalyst provided between said first catalyst and said heat exchanger in said passage, said second catalyst allowing a second combustion of a second mixture of said hydrogen gas and said air in said second

catalyst, when said second catalyst is heated by said first combustion.

7. A hydrogen combustion heater according to claim 6, wherein said second combustion is limited to a mild oxidation that is defined as being free from firing of said hydrogen gas.

8. A hydrogen combustion heater according to claim 6, wherein temperatures of said first and second catalysts during said first and second combustions are each limited to 500℃ or lower.

9. A hydrogen combustion heater according to claim 1, wherein said first catalyst comprises:

a first electrode;

a corrugated sheet wound around and electrically connected to said first electrode;

a catalyst supported on said corrugated sheet; and

a second electrode electrically connected to an outer portion of said corrugated sheet.

10. A hydrogen combustion heater according to claim 6, wherein said first catalyst is smaller than said second catalyst in volume,

wherein a first flow rate of said first mixture for starting said first combustion in said first catalyst is adjusted to about Q_1 defined by the following expression:

$$Q_1 = Q_s \times V_1/(V_1 + V_2)$$

where Q_s is a flow rate of a mixture of said hydrogen gas and said air under a steady state operation of said hydrogen combustion heater for conducting a second combustion in said first and second catalysts, V_1 is a volume of said first catalyst, and V_2 is a volume of said second catalyst.

11. A hydrogen combustion heater according to claim 6, wherein said second catalyst is greater than said first catalyst in cross-sectional area.

12. A hydrogen combustion heater according to claim 1, further comprising a mixer for mixing together said hydrogen gas and said air, said mixer being provided upstream of said first catalyst in said passage.

13. A hydrogen combustion heater according to claim 12, wherein said mixer comprises a honeycomb structure prepared by winding together a flat sheet and a corrugated sheet, each of said flat and corrugated sheets comprising a plurality of holes.

14. A hydrogen combustion heater according to claim 9, wherein said first catalyst comprises at its outer portion a plurality of holes.

15. A hydrogen combustion heater according to claim 9, wherein said first catalyst comprises at its upstream portion a plurality of holes.

16. A hydrogen combustion heater according to claim 1, further comprising:

a blower for introducing said air into said passage; and

a hydrogen introducing pipe for introducing said hydrogen gas into said passage, said hydrogen introducing pipe comprising:

(a) a first hydrogen passage comprising a first valve; and

(b) a second hydrogen passage comprising a second valve,

wherein, when said first valve is opened, a first flow rate of said hydrogen gas is allowed, thereby starting said first combustion,

wherein, when said first and second valves are opened, a second flow rate of said hydrogen gas is allowed, thereby conducting a second combustion of said hydrogen gas and said air under a steady state operation of said hydrogen combustion heater.

17. A hydrogen combustion heater according to claim 1, further comprising:

a blower for introducing said air into said passage; and

a hydrogen introducing pipe for introducing said hydrogen gas into said passage, said hydrogen introducing pipe comprising:

(a) a first stop valve for stopping hydrogen flow in said hydrogen introducing pipe;

(b) a first hydrogen passage comprising a first restrictor; and

(c) a second hydrogen passage comprising (1) a second stop valve for stopping hydrogen flow in said second hydrogen passage and (2) a second restrictor,

wherein said first and second stop valves are each operated by a working fluid that is air or an inert gas,

wherein, when said first stop valve is opened, said first restrictor provides a first flow rate of said hydrogen gas, thereby starting said first combustion,

wherein, when said first and second stop valves are opened, a second flow of said hydrogen gas is allowed, thereby conducting a second combustion of said hydrogen gas and said air under a steady state operation of said hydrogen combustion heater.

18. A hydrogen combustion heater according to claim 1, further comprising a hydrogen introducing pipe for introducing said hydrogen gas into said passage, said hydrogen introducing pipe comprising a discharge portion inserted in said passage, said discharge portion comprising a hole for discharging said hydrogen gas into said passage, said hole being directed upstream of said passage.

19. A hydrogen combustion heater according to claim 18, wherein said hole comprises at least first and second holes, and said first hole is positioned at about a center of said discharge portion of said hydrogen introducing pipe, and said second hole is positioned between said center and an upstream end in said discharge portion

20. A hydrogen combustion heater according to claim 18, wherein said discharge portion is divided into upstream and downstream halves with respect to hydrogen gas flow in said discharge portion,

wherein said hole comprises a first hole positioned in said upstream half and a second hole positioned in said downstream half,

wherein a total opening area of said first hole is greater than that of said second hole.

21. A hydrogen combustion heater according to claim 20, wherein said discharge portion of said hydrogen introducing pipe extends substantially horizontally in said passage.

22. A hydrogen combustion heater according to claim 20, wherein said first hole comprises first holes, and said second hole comprises second holes,

wherein each of said first holes and said second holes is substantially the same in opening size,

wherein said first holes in said upstream half are greater in number than said second holes in said downstream half.

23. A hydrogen combustion heater according to claim 20, wherein said first hole comprises first holes, and said second hole comprises second holes,

wherein at least a part of said first holes is greater than said second holes in opening size.

24. A hydrogen combustion heater according to claim 18, wherein said hole is directed upstream of said passage to be within 45 degrees down from horizontal.

25. A hydrogen combustion heater according to claim 12, wherein said mixer comprises first, second and third members in a downstream direction of said passage,

wherein said first, second and third members respectively comprise a first through hole of a first size, second through holes of a second size and third through holes of a third size, for allowing said hydrogen gas and said air to pass therethrough,

wherein said first, second and third sizes are in descending order,

wherein the number of said first, second and third through holes are in ascending order.

26. A hydrogen combustion heater according to claim 1, wherein said heat exchanger comprises:

upstream and downstream partition walls respectively comprising first holes and second holes; and

a plurality of pipes each extending between said first hole and said second hole, each pipe having a space around each pipe, said space allowing a heating medium to flow therethrough.

27. A method for using a hydrogen combustion heater according to claim 1, comprising controlling a flow rate ratio of said air to said hydrogen gas, thereby limiting said first combustion to a mild oxidation that is defined as being free from firing of said hydrogen gas.

28. A method according to claim 27, wherein said flow rate ratio is controlled to be greater than 8:1.

29. A method according to claim 27, wherein temperature of said first catalyst is limited to 500℃ or lower.

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